LESSON 13

The Requirements of Appendix F Quality Assurance Requirements for Continuous Gas Emission Monitors

Lesson Goal and Objectives

Goal

To describe the requirements of the Code of Federal Regulations, Title 40 Part 60 *Appendix* F, Procedure 1 - Quality Assurance Requirements for Continuous Gas Emission Monitoring Systems.

Objectives

At the end of this lesson you should be able to -

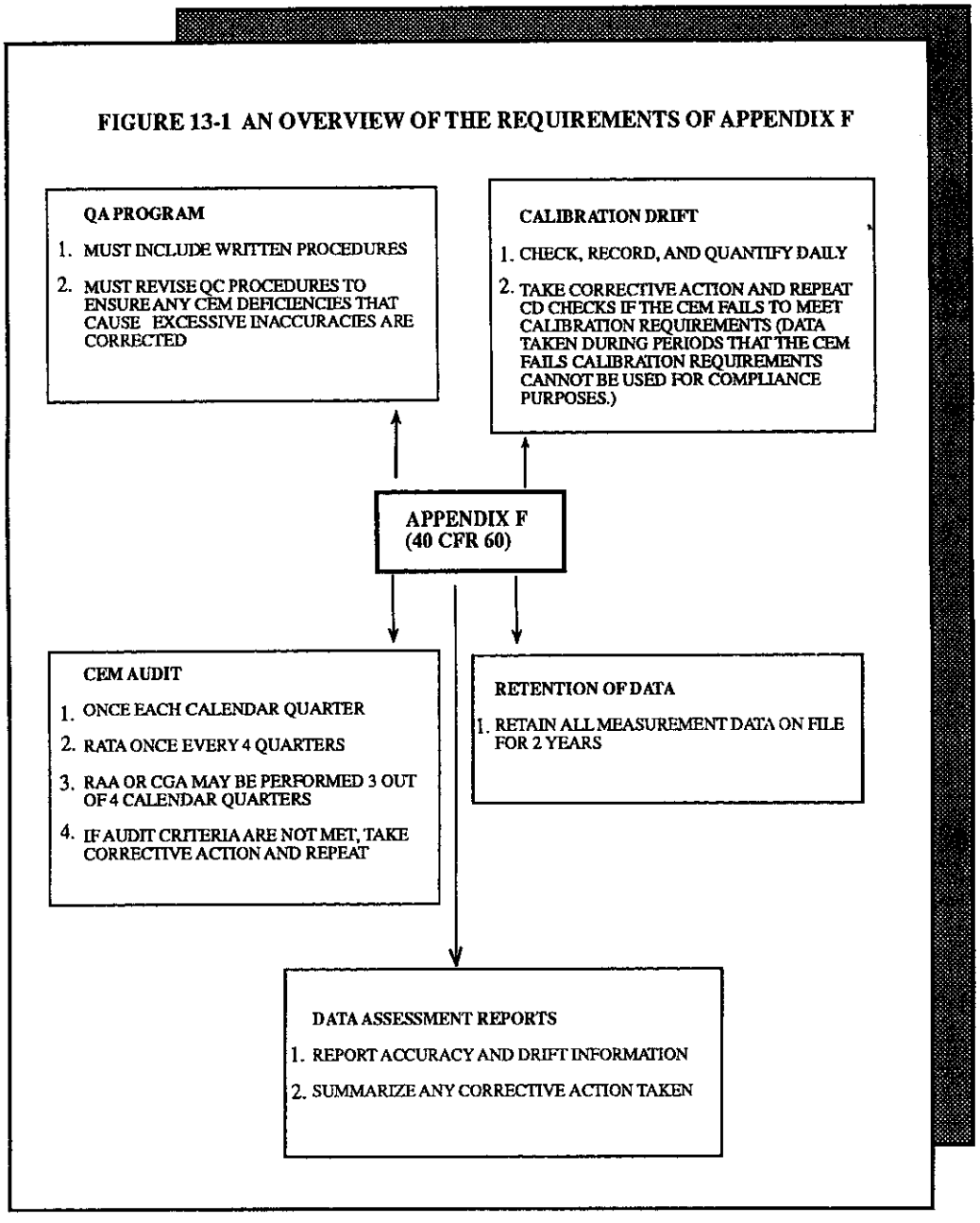
1. define the two functions of the quality control (QC) procedures required in Procedure 1 of *Appendix* F,
2. describe the minimum QC requirements which source owners must implement in their continuous emission monitoring program,
3. define the criteria for determining excessive drift in a continuous emission monitoring system (CEMS), and
4. describe the three acceptable methods for performing Data Accuracy Assessments.

Introduction

In the last lesson, we learned about the regulatory requirements of *Appendix* B (Specification Test Procedures) of Part 60 of Title 40 of the Code of Federal Regulations. In this lesson, we will explore the requirements in *Appendix* F of Part 60. *Appendix* F is entitled "*Appendix* F - Quality Assurance Procedures, Procedure 1 - Quality Assurance Requirements for Gas Continuous Emission Monitoring Systems for Compliance Determination" and was promulgated at 52 FR 21007 on June 4, 1987. These procedures apply to steam generating units which are

subject to the requirements of 40 CFR 60 Subparts Da and Db. *Appendix* F requires that the source implement written quality assurance procedures, states the acceptable values in performing calibration drift assessments and data accuracy assessments, and gives the requirements for reporting the data to the regulatory agency. The requirements of *Appendix* F are summarized in *Figure* 13-1.

FIGURE 13-1 AN OVERVIEW OF THE REQUIREMENTS OF APPENDIX F



In this lesson, we will take a look at each of the following sections of *Appendix* F:

- Applicability and Principle (*Section* 1),
- Definitions (*Section* 2),
- Quality Control Requirements (*Section* 3),

- Calibration Drift (CD) Assessment (*Section* 4),
- Data Accuracy Assessment (*Section* 5),
- Calculations for CEMS Data Accuracy (*Section* 6), and
- Reporting Requirements (*Section* 7).

Applicability and Principle - Section 1

Section 1.0 , Procedure 1 of *Appendix* F, sets forth procedures for evaluating the effectiveness of quality assurance/quality control procedures as well as evaluating the quality of data produced by CEMS that are used for determining compliance with emission standards.

This section also states that the QC procedures required by Procedure 1 have two distinct but equally important functions. The first function is assessment of CEMS data quality by estimating the accuracy of the monitor. The second function is that of control and improvement of data from a continuous emission monitor (CEM) through the implementation of QC policies and corrective actions. A control loop is formed through the interaction of these two functions as follows; whenever the assessment function demonstrates that the data quality is inadequate, the control effort has to be increased until the quality of the data is acceptable.

Section 1 also specifies the methods for assessing response drift and accuracy of the CEM and these methods are based on methods found in *Appendix* B, Part 60. Procedure 1 allows source owners a great deal of latitude in the development of QC procedures in order for these to be as effective and efficient for source specific situations. In some circumstances, source owners may specify certain sections of the CEMS instrument manual (i.e., the manual which is published by the manufacturer) as their written procedures.

Definitions - Section 2

Section 2 provides the definitions of several terms and continuous emission monitor (CEM) parameters. They are:

1. continuous emission monitoring system;
2. diluent gas;
3. span value;
4. zero, low-level and high-level values;
5. calibration drift (CD); and
6. relative accuracy (RA).

The definitions for CEMS, calibration drift, relative accuracy and span value are the same as those contained in *Appendix* B of Part 60. These terms were discussed in the last lesson. A "diluent gas" is defined as a major gaseous constituent in a gaseous pollutant mixture. CO_2 and O_2 are the major gaseous constituents of interest for combustion sources. "Zero, low-level and high-level values" refer to the CEMS response value as it relates to the source-specific span value. Procedures for determining these values are presented in the appropriate performance specification tests in *Appendix* B.

Quality Control Requirements - Section 3

Section 3 requires source owners to develop and implement a quality control program which, as a minimum, must include detailed procedures for the following activities:

1. calibration of the CEMS;
2. calibration drift determination and adjustment of the CEMS;
3. preventive maintenance of the CEMS (which includes maintaining a spare parts inventory);
4. data recording, calculations, and reporting for emissions and QA data;
5. accuracy audit procedures which includes sampling and analysis methods; and
6. the program of corrective action for the malfunctioning CEMS.

The reader should note that *Section* 3 does not provide detailed discussion of these activities. The following sections to *Appendix* F contain requirements for these activities:

- *Section* 4 - Calibration drift determination and adjustment of the CEMS, corrective action for the malfunctioning CEMS, and data recording;
- *Section* 5 - Accuracy audit procedures and corrective action for the malfunctioning CEMS;
- *Section* 6 - Data recording and calculations; and
- *Section* 7 - Reporting requirements for emissions and QA data.

Since none of the sections in *Appendix* F specifically address calibration of a CEMS, we will briefly mention this term. The calibration of a CEM refers to the adjustment of the instrument relative to specified gas standards or independent effluent measurements. Written procedures for calibrating a CEM are required and each source may develop its own procedures. As stated earlier in *Section* 1, applicable sections of an instrument's operating manual may suffice for these written procedures. The reader should take note that there are no current regulations regarding specific calibration frequencies or specific criteria for initiating calibration procedures. Therefore, sources should implement their own procedures for determining the calibration frequency and criteria for calibrating a CEM based on operating experience or manufacturer's recommendations.

Preventive maintenance is also not addressed in detail in *Appendix* F. Preventive maintenance consists of such activities as routine maintenance and repairs and instrument adjustments performed on an as-needed basis. We will talk more about maintenance for continuous gas emission monitors in Lesson 15.

Finally, *Section* 3 states that if excessive inaccuracies in data occur for two consecutive quarters, then the source owner must either revise the current written procedures or modify or replace the CEMS in order to correct this deficiency. Written QC procedures must be kept on file and must be available for inspection by the regulatory agency. In the next lesson, we will talk about quality control in more detail.

Calibration Drift (CD) Assessment - Section 4

This section discusses the requirements for performing the calibration drift (CD) assessment tests. As we learned in Lesson 12, "calibration drift" refers to the difference between the CEMS output reading and a reference value after a period of operation during which no unscheduled maintenance, repair, or adjustment took place. Part 60.13 of Title 40 of the Code of Federal Regulations, requires that daily zero (or low-level) and span drift checks be performed. These same two checks are also used to fulfill the CD assessment requirements of *Appendix* F. Written procedures are required for specifying how the zero and span calibration drift determinations will be performed. Also, these procedures must be consistent with the methods prescribed by the CEM vendor.

Table 13-1 is a compilation of the performance specification criteria and the required response by the source owner or operator if the zero and span calibration drift exceeds the allowed limit. It should be noted that a source may develop response requirements more stringent than those as stated in this table. The written procedures for the performance of calibration drift, should incorporate the criteria for adjusting the CEMS should the calibration drift test show that the instrument is out of line. Making corrections for excessive drift involves any type of

Table 13-1
CEMS CALIBRATION DRIFT CRITERIA

PARAMETER	CRITERION*	ACTION REQUIRED
Zero (or low) level calibration drift	CD> 2 x (Spec)**	Adjust CEMS for calibration drift
	CD> 2 x (Spec) for 5 consecutive 24-hour periods	CEMS out-of control period begins at end of 5th day the CD exceeds 2 x (Spec); perform corrective action and repeat CD check
	CD> 4 x (Spec)	CEMS out-of-control period begins at the ti;me corresponding to the completion of the last acceptable CD check preceding the CD check which exceeds 4 x (Spec); perform corrective action and repeat the CD check
Span calibration drift	CD> 2 x (Spec)**	Adjust CEMS for calibration drift
	CD> 2 x (Spec) for 5 consecutive 24-hour periods	CEMS out-of-control period begins at end of 5th day the CD exceeds 2 x (Spec); perform corrective action and repeat CD check
	CD> 4 x (Spec)	CEMS out-of-control period begins at the time corresponding to the completion of the last successful CD check preceding the CD check that exceeds 4 x (Spec); perform corrective action and repeat the CD check

* Spec refers to the applicable performance specification 40 CFR Part 60, Appendix B, Performance Specification.
Example - In Performance Specification Test 2 (for SO NO Systems), the calibration drift must not deviate from the reference standard by more than 2.5% of the span value. Hence 2 x (spec) = 2x 2.5%=5%.

** This is the minimum criterion for adjustment of the CEMS. More stringent criteria, which may be preferred by many sources, are also acceptable.

adjustments which the CEM operator deems necessary in order to correct the observed drift. Activities such as routine checks and adjustments of calibration and sample gas flow rates, pressures, filter elements and moisture removal systems; verification of the status of monitor-specific auxiliary monitoring parameters (i.e., sample cell temperature and pressure, gas flow capillaries, detection optics and electronics, temperature compensation, linearization signal output circuitry); and adjustments of zero and/or span potentiometers are included in the procedure for compensating for excessive drift. The source owner should have written procedures for performing drift adjustments and these procedures should include the criteria for demonstrating that the adjustments that were made are adequate.

If the zero (low-level) or the span (high-level) values exceed four times the applicable drift specification as stated in *Appendix* B, the CEM is considered to be out-of-control. Whenever this happens, *Appendix* F requires that corrective action be taken. The type of action taken will depend on the nature of the problem. Written procedures are required to be available for addressing instrument start-up and trouble shooting. CEM instrument operation and/or repair manual sections applicable to out-of-control problems will suffice for these written procedures. It is also suggested that additional quality assessment procedures be written for the purpose of verifying that the CEMS is in control following any repair or adjustment. Alternative methods used for monitoring emissions during the out-of-control period should be listed in these quality assessment procedures. These procedures should also list the office or individual responsible for handling an out-of-control event. Such a listing would include the personnel in charge of approving the corrective action to be taken, and procedures for determining when alternative methods for emission monitoring should be performed. The criteria for determining that a CEMS is out of control must include the procedure from *Appendix* F for determining excessive drift and excessive inaccuracy.

Section 4 of *Appendix* F also states requirements for CEMS that have automatic adjustments for resetting the CD. Such systems must be programmed to record the unadjusted concentration measured in the CD prior to resetting the calibration if performed, or record the amount of adjustment (e.g., a microprocessor control would do this).

Lastly, *Section* 4 states that all measurements from the CEMS are required to be retained on file for at least two years as required in 40 CFR Part 60.7(d). However, emission data recorded on each day that the CEMS is out-of-control need not be included in the daily data requirement of the applicable subpart in Part 60.

Data Accuracy Assessment - Section 5

Appendix F became effective on December 4, 1987 and the first required relative accuracy test was to be performed by March 4, 1988 or by the date a CEMS initial performance test was required by the applicable regulation, whichever date was later.

This section lists the three acceptable techniques which can be used for performing an audit on the CEM. Audits are required to be performed at least once each quarter. The three acceptable techniques are:

1. Relative Accuracy Test Audits (RATA),
2. Cylinder Gas Audits (CGA), and
3. Relative Accuracy Audits (RAA).

In addition to these procedures, *Appendix* F states that the EPA may approve alternative procedures to be used during three of the four calendar quarters. However, one RATA is required at least once every four calendar quarters. The reader should note that currently, there have been no alternative procedures approved by the EPA and only one procedure for an RAA test for in-situ systems is currently under review.

A CEMS which does not demonstrate adequate accuracy during any quarterly audit test is considered to be out-of-control with corrective action necessary. As we learned in *Section* 3, if the CEMS does not demonstrate an acceptable accuracy for two consecutive quarters, then either the QA program must be revised or the CEMS must be replaced or modified. *Table* 13-2 delineates the specific requirements and performance criteria for each of the three acceptable audit techniques. *Appendix* F requires that the QC program must have written sampling and analysis procedures to be used during the required quarterly accuracy audits.

Table 13-2.
Requirements and Criteria for Appendix F, Procedure 1 Audit Techniques

TECHNIQUE	REQUIREMENTS	PERFORMANCE CRITERIA	WHEN REQUIRED
Relative Accuracy Test Audit	Conduct as per applicable performance specification (PS) in 40 CFR Part 60 Appendix B, performance specifications (e.g., PS 2 for SO and NO) Analyze appropriate performance audit samples from EPA	Relative accuracy must not exceed 20% or 10% of applicable standard, whichever is greater For SO_2 standards from 0.20 to 0.30lb / million Btu, relative accuracy must not exceed 15% of the standard For SO_2 standards below 0.20 lb/10^6 Btu, relative accuracy must not exceed 20% of the standard	Once every four calendar quaaters
Relative Accuracy Audit	Conduct as per applicable PS in Appendix B except only 3 runs are required Use relative difference between the mean reference method values and the mean of the CEMS responses to assess the accuracy of the CEMS data	Inaccuracy must not exceed ± 15% or 7.5% of the applicable standard, whichever is greater	May be performed in three of the four calendar quarters
Cylinder Gas Audit	Challenge both pollutant and dilutant channels (if applicable) of CEMS three times at the two points specified in Procedure 1 Use gases that have been certified by comparison to NBS SRM's or NBS/EPA approved gas manufacturer's CRM's Operate analyzer in normal sample mode Use average difference between actual gas value and concentration indicated by CEMS to access accuracy	Inaccuracy must not exceed ± 15%	May be performed in three of the four calendar quarters

As stated earlier, *Appendix* F requires that these accuracy audits be performed once each calendar quarter. Additionally, successive audits must occur no closer than two months apart and must be conducted as follows:

1. The RATA test must be performed once every four calendar quarters. This test is performed the same way that the performance specification test #2 (for SO_2 and NO_x) as outlined in *Appendix* B is done. However, *Appendix* F also requires that EPA performance audit samples be taken sequentially (i.e., shortly before or after) with the RATA samples. Both the EPA audit sample and the RATA sample must be analyzed by the same person. The logic behind conducting these two tests sequentially is that the RATA will approximate the "truth" by the Reference Method test results which are then checked for analytical accuracy by the EPA audit method.

   The EPA audit samples are performed the same way that the applicable Reference Methods (e.g., Methods 6 for SO_2 and 7 for NO_x) as delineated in Part 60 *Appendix* A, are performed. The EPA audit samples and the data samples are concurrently analyzed in the same manner in order to determine that the technique of both the sample analyst and the audit sample preparation are effective. The results of the EPA audit sample must agree within five percent of the audit concentration on each of two SO_2 audit samples or within ten percent of each other on each of two NOx samples.

2. Where applicable, a CGA may be performed in three of the four calendar quarters. An example of a situation where a CGA could not be performed would be in the case of a path in-situ monitor which could not undergo this test unless a flow-through cell is used.

   This audit is performed by checking the CEMS (both pollutant and diluent monitors, if applicable) with an audit gas following EPA Traceability Protocol No. 1 (see citation in the Reference section). An audit gas must be certifiable through comparison with a National Institute of Standards and Technology -Standard Reference Materials (NIST-SRM) gaseous reference or NIST/EPA-approved gas manufacturers CRM Certified Reference Material (CRM). This audit gas of a known concentration is used to check the CEM at two points within the following ranges:

Audit range			
		Dilute monitors for - -	
Audit	Pollutant monitors	CO_2	O_2
1	20 to 30% of span value	5 to 8% by volune	4 to 6% by volume
2	50 to 60% of span value	10 to 14% by volume	8 to 12% by volume

It should be noted that a separate audit gas cylinder must be used for each point checked. This cylinder gas cannot be diluted. Check the CEM at each point three times and use the average response value for computing the accuracy. Also, each point should be sampled long enough to assure absorption-desorption of the CEMS sample transport surfaces has stabilized. Audit each monitor in its normal sampling mode (i.e., allow the audit gas to pass through all filters, scrubbers, conditioners as well as the other components used during normal sampling and as much of

the sampling probe as possible). The audit gas should be injected at the connection between the probe and the sample line. The accuracy is the difference between the concentration of the audit gas and the concentration as indicated by the monitor.

3. The RAA test may be performed three of the four calendar quarters. This test is performed the same way in which the relative accuracy test of *Appendix* B is performed with two exceptions; 1) only three sets of measurements are required, and 2) EPA performance audit samples are required to be analyzed concurrently with the RAA samples. The EPA audit sample and the RAA test sample must be taken by the same person. The CEMS accuracy is determined by the relative difference between the mean of the CEMS values (in terms of the standard) and the mean of the Reference Method results. That is to say, the audit sample verifies the accuracy of the *Appendix* B Reference Method test used, then the Reference Method test is used to "audit" the CEM.

The data accuracy assessment is an important check of the CEMS ability to produce accurate emissions data over time. One should not expect that accuracy will remain constant over each quarter because of changes in calibration gases, analysts and environment.

Calculations For CEMS Data Accuracy - Section 6

This section gives the types of calculations necessary to assess the accuracy of the CEM. For the RATA relative accuracy calculation, the equations used are contained in *Section* 8 of *Appendix* B, Performance Specification Test 2. We talked about these equations in the last lesson. Before proceeding any further in this section, the reader may wish to go back to Lesson 12 and review these equations. While the RATA and RAA must be calculated in units of the applicable standard (e.g., lb./million BTU), the CGA must be calculated in units of the appropriate concentration (i.e., ppm SO_2 or percent O_2).

Equation 13-1 can be used by combustion sources to convert a pollutant concentration to units of the applicable standard as follows:

(*Eq.* 13-1) $$E = CF \left[\frac{20.9}{20.9 - \text{percent } O_2} \right]$$

where

E = pollutant emission, ng/J (1b/million Btu),
C = pollutant concentration, ng/dsm^3 (lb/dscf)*
F = factor representing a ratio of the volume of dry fuel gas generated to the caloric value of the fuel, dsm^3/J (dscf/million Btu),
20.9 = a constant which refers to the amount (percent) of O_2 in the ambient air.

Percent O_2 = oxygen content by volume (expressed as percent), dry basis in the sample stream.

* dsm = Dry Standard Cubicmeter
dscf = Dry Standard Cubic Feet

Data from CEMSs are sometimes collected on a wet basis. When comparing the CEM data with the Reference Method data it is necessary to convert the wet basis data to a dry basis. This conversion can be done as shown in *equation* 13-2:

(*Eq.* 13-2)
$$X_{ppm,\,dry} = \frac{X_{ppm,\,wet}}{1 - B_{ws}}$$

where:

X = Concentration from the CEMS

B_{ws} = Moisture fraction of the CEMS gas sampled. This value is determined by using Part 60 *Appendix* A, Method 4.

Part 60, *Appendix* A, Method 19 presents a complete explanation of equations 13-1 and 13-2.

As we stated earlier, the RATA relative accuracy is determined by using the equation contained in *Section* 8 of *Appendix* B, Performance Specification Test 2. The RAA test accuracy and the accuracy of the CEM per the CGA method are calculated by using the same equation. Equation 13-3 is the mathematical expression used for determining both the RAA and the CGA and is presented as follows:

(*Eq.* 13-3)
$$A = \frac{C_m - C_a}{C_a} \times 100$$

where:

A = The accuracy of the CEMS (percent),

C_m = average CEMS response during audit in units of applicable standard, (for RAA), or

C_a = average audit value (CGA certified value or three - run average for RAA) in units of the applicable standard or appropriate concentration.

Reporting Requirements - Section *7*

The results of each CEMS accuracy audit must be reported in the form of a Data Accuracy Report (DAR). After each quarterly audit, one copy of the DAR must be submitted to the state regulatory agency or in some cases the EPA Regional Office along with a report of emissions required under the applicable regulation (i.e., the requirements of subparts Da and Db in Part 60). The minimum information required to be submitted with a DAR is as follows:

1. Source owner or operator name and address.

2. Identification and location of monitors in the CEMS.

3. Manufacturer and model number of each monitor in the CEMS.

4. Assessment of CEMS data accuracy and date of assessment as determined by a RATA, RAA or CGA, including the relative accuracy for the RATA, the accuracy for the RAA or CGA, the Reference Method results, certified values for the cylinder gases, the CEMS responses, and the CEMS accuracy

calculation results. If the accuracy audit results show the CEMS to be out-of-control, the CEMS operator shall report both the audit results showing the CEMS to be out-of-control and the results of the audit following corrective action showing the CEMS to be operating within specifications.

5. Calibration drift (CD) assessment results.

6. Results from the EPA performance audit samples.

7. Summary of all corrective actions taken when the monitor was determined out-of-control.

Figure 13-2 is an example of what a DAR form looks like.

Figure 13-2 *Example format for data assessment report (DAR).*

Period ending date _____ **Year** _____
Company name _____
Plant name _____ **Source unit no.** _____
CEMS manufacturer _____ **Model no.** _____
CEMS serial no. _____ **CEMS type (e.g., in-situ)** _____
CEMS sampling location (e.g., control device outlet) _____
CEMS span values as per the applicable regulation, SO_2 ppm _____
O_2 _____ **percent,** **NO_x** _____ **ppm,** **CO_2** _____ **percent**

I. *Accuracy assessment results (Complete A, B, or C below for each CEMS or for each pollutant and diluent analyzer, as applicable.) If the quarterly audit results show the CEMS to be out-of- control, report the results of both the quarterly audit and the audit following the corrective action showing the CEMS to be operating properly.*

A. *Relative accuracy test audit (RATA) for* _____ (e.g., SO_2 in ng/J).
1. Date of Audit _____.
2. Reference methods (RM's) used _____ (e.g., Methods 3 and 6).
3. Average RM value _____ (e.g., ng/J, mg/dsm³, or percent volume).
4. Average CEMS value _____.
5. Absolute value of the mean difference $|\bar{d}|$ _____.
6. Confidence coefficient |CC| _____.
7. Percent relative accuracy (RA) _____ percent.
8. EPA performance audit results:

a. Audit lot number	(1) _____	(2) _____
b. Audit sample number	(1) _____	(2) _____
c. Results (mg/dsm³)	(1) _____	(2) _____
d. Actual value (mg/dsm³)*	(1) _____	(2) _____
e. Relative error*	(1) _____	(2) _____

B. *Cylinder gas audit (CGA) for* _____ (e.g., SO_2 in ppm).
1. Date of audit _____.

	Audit point 1	Audit point 2	
2. Cylinder ID number	_____	_____	
3. Date of certification	_____	_____	
4. Type of certification	_____	_____	(e.g., EPA Protocol 1 or CRM).

Figure 13-2 (Continued)

5. Certified audit value _____ (e.g., ppm).
6. CEMS response value _____ (e.g., ppm).
7. Accuracy _____ percent.

C. *Relative accuracy audit (RAA) for* _____ (e.g., SO_2 in ng/J).

1. Date of audit _____ .
2. Reference methods (RM's) used _____ (e.g., Methods 3 and 6).
3. Average RM value _____ (e.g., ng/J).
4. Average CEMS value _____ .
5. Accuracy _____ percent.
6. EPA performance audit results:

a. Audit lot number	(1)	_____	(2)	_____
b. Audit sample number	(1)	_____	(2)	_____
c. Results (mg/dsm^3)*	(1)	_____	(2)	_____
d. Actual value (mg/dsm^3)*	(1)	_____	(2)	_____
e. Relative error*	(1)	_____	(2)	_____

D. *Corrective action for excessive inaccuracy.*

1. Out-of-control periods.
   a. Date(s) _____ .
   b. Number of days _____ .
2. Corrective action taken _____
3. Results of audit following corrective action. (Use format of A, B, or C above, as applicable.)

II. Calibration drift assessment.

A. Out-of-control periods.
   1. Date(s) _____ .
   2. Number of days _____ .
B. Corrective action taken _____

**To be completed by the Agency*

Summary

The requirements of Part 60 of Title 40 *Appendix* F, Procedure 1 apply to steam generating units listed in Part 60 Subparts Da and Db. *Appendix* F requires that these sources implement written quality control procedures for evaluating the quality data produced by continuous emission monitoring systems. In particular, the source is required to perform calibration drift (CD) tests (i.e., daily zero and scan value checks.) Both the zero and span values cannot exceed the applicable drift specifications as stated in *Appendix* B to Part 60 and the measurement data must be retained on file for two years except in cases where the CEM is deemed out-of-control.

The source is also required to perform quarterly audits of the CEM. The three acceptable audits which can be used are the relative accuracy test audit (RATA), which must be performed at least once ever four calendar quarters, the relative accuracy audit (RAA), and the cylinder gas audit (CGA). Both the RAA and CGA may be

performed in three of the four calendar quarters. The RATA and RAA are performed in the same manner which the relative accuracy test as required by Part 60 *Appendix* B are performed. The RAA test only requires that three sets of data be used as opposed to taking nine sets of data which *Appendix* B requires. Additionally, EPA audit samples must be analyzed sequentially with the RATA and/or RAA test samples. The CGA test is performed by checking the CEM at two point within specific ranges with an audit gas.

The results of CEMS accuracy tests must be recorded on a Data Accuracy Report (DAR) form each quarter and a copy of this form along with a report of source emissions required under Subparts Da and Db must be submitted to the regulatory agency.

REVIEW EXERCISES	
1. True or false. The two distinct but equally important functions of the QC procedures required by *Appendix* F are to 1) assess the quality of the CEMS data by estimating the monitors accuracy, and 2) to control and improve the quality of the CEMS data through the implementation of QC policies and corrective actions.	
2. True or false. The inclusion of a spare parts inventory is one of the several QC requirements which source owners must implement in their CEMS program.	1. True
3. True or false. *Appendix* F states that if excessive inaccuracies in data occur for two consecutive quarters, then the source owner shall replace the CEMS.	2. True
4. In performing the daily calibration drift test for both zero and span drift, the CEMS is considered to be out-of-control if: a. The CD > 4x the allowable limit b. The CD > 2x the allowable limit c. The CD > 5x the allowable limit d. The CD > 10x the allowable limit	3. False
5. True or false. The RAA Test requires that only 3 sets of measurements be taken.	4. a
6. True or false. A CGA Test may be performed in any of four calendar quarters.	5. True
7. The audit gas used in performing the CGA Test is used to check the CEM at _____ point(s) within the specified ranges.	6. False
8. The RAA Test may be performed during _____ of the four calendar quarters.	7. Two

9. The performance criteria for the RATA Test requires that the RA must not exceed ____ or ____ of the applicable standard, whichever is greater. a. 20% or 10% b. 10% or 15% c. 20% or 15% d. 5% or 10%	8. Three
10. True or false. The equation used to convert a pollutant concentration to units of the applicable standard is as follows: $E = CF \left[\frac{20.9}{20.9 - \text{percent } O_2} \right]$ The percent O_2 in this equation is the oxygen content by volume (expressed as percent), wet basis in the sample stream.	9. a
	10. False

REFERENCES

1. Code of Federal Regulations, Title 40 Part 60, *Appendix* F - Quality Assurance Procedures.

2. Environmental Protection Agency. 1987. *Appendix* F - Quality Assurance Procedures. Procedure 1 — Quality Assurance Requirements for Gas Continuous Emission Monitoring Systems used for Compliance Determination. Summary of Comments and Responses. EPA/450/3-87/009.

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4. Environmental Protection Agency. 1986. Continuous Emission Monitoring (CEM) Systems Good Operating Practices. *Section* 3.0.9 of the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II Stationary Source Specific Methods. EPA -600/4-77-0276.

5. Environmental Protection Agency. 1985. Guideline for Developing Quality Control Procedures for Gaseous Continuous Emission Monitoring Systems. *Section* 3.0.10 of the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II Stationary Source Specific Methods. EPA -600/4-77-0276.

6. Environmental Protection Agency. 1978. Traceability Protocol for Establishing True Concentrations of Gases used for Calibration and audits of Continuous Source Emission Monitors (Protocol Number 1). *Section* 3.04 of the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III. Stationary Source Specific Methods. EPA -600/4-77-0276.

7. Electric Power Research Institute. 1988. Continuous Emission Monitoring Guidelines: Update. EPRI CS-5998